DATA CENTER ENERGY CHARACTERIZATION STUDY SITE REPORT

DATA CENTER FACILITY 2

FEBRUARY 2001

I. Review of Site Characteristics

Facility

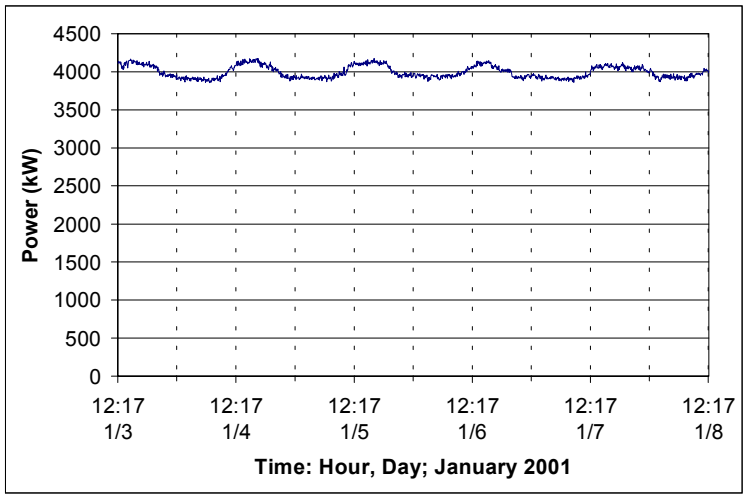
Facility 2 is an 118,700 square foot (sf) data center facility located in Silicon Valley, California. The facility consists of four levels and is located in a two-story building. The building houses 60,400 sf of data center space, 58,300 sf of office space, 6,800 sf of support space, and 4,600 sf of electrical room space. This facility provides co-location service, which is an unmanaged service that provides rack space and network connectivity via a high-capacity backbone. Data center space occupies approximately half of the building area. During the monitoring period, the data center was 65 percent occupied. Combined office and support space accounts for 55 percent of the building area. The data center's environmental system operates 24 hours a day year-round. The users of the co-location space require full access to and control of their caged space 24 hours a day.

Customer Cage

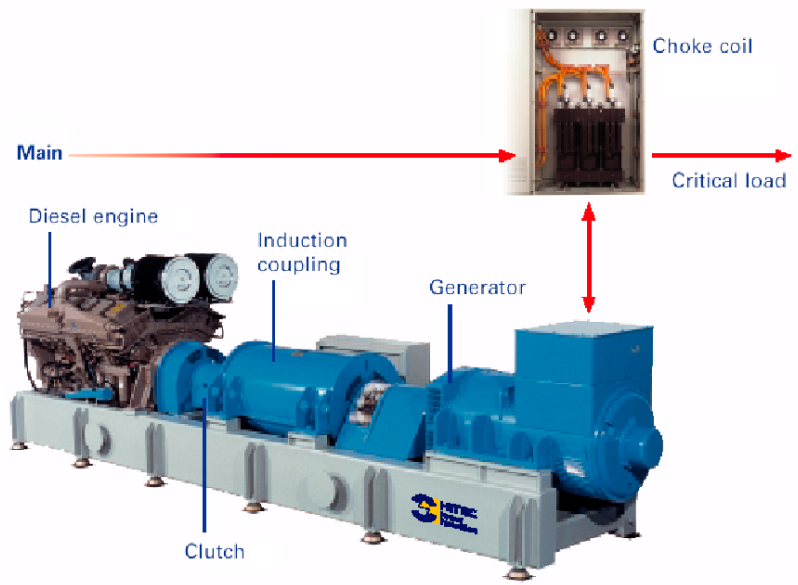
Electrical Equipment and Backup Power System

The electricity use at Data Center Facility 2 was monitored from January 3, 2001 through January 10, 2001. An average kVA of 4,190 and an average of 4,000 kW were being drawn over the monitoring period. The load factor over the period was 0.96, and the load varied ± 4% from the average.

Chart 1. Whole Building Power Consumption



The facility utilizes five dynamic uninterruptible power supply (UPS) system modules. (See picture below). The generators condition the incoming utility power via the choke coil in order to remove any irregularities in the signal. This is achieved by having a constantly spinning generator in parallel with the main service feed. The induction coupling is also kept spinning so that the generator will continue producing electricity in the event of a power loss. In such an event, the Mitsubishi diesel engines will start up and engage to the induction coupling via the clutch to keep the generator turning. Each generator at full load can provide 1,500 kW apiece for 40 hours. The electrical system is designed for N+2 redundancy.



Uninterruptible Power Supply Module

Mechanical Systems

Condenser Units

The mechanical pad on the building rooftop consists of 75 air-cooled condensers for the CRAC (computer room air conditioning) units, five exhaust fans, one outside air supply fan, five package air conditioning/heating units, three humidifiers and two hot water boilers. The hot water boilers are for the four office package units. The rooftop mezzanine houses the UPS systems, nine exhaust fans, and four electric block heaters. The block heaters are used to pre-heat the diesel engine block of the UPS system.

The data center is on a raised floor, through which cooling air is circulated via the CRAC units. Seventy Data Aire CRAC units with a nominal capacity of twenty-five tons each, serve the data center space. In addition to the CRAC units, a 40 ton package unit adds humidification and cooling to the data center. The room temperature and relative humidity are maintained at an average of 70 °F and 45 %, respectively. The data center is divided into 11 rooms and each have a cooling system designed for N+1 redundancy. The EER (energy efficiency rating) of the Data Aire CRAC unit is 9.6. The facility also has three indoor electrical rooms. Two of these require cooling, provided by five CRAC units.

II. Electricity Use Characteristics

The facility's end-use of electricity is shown below in Table 1 and Chart 2. "Other" was calculated by subtracting all of the measured and calculated data from the "Whole Building" power. Eighty-two percent of the power goes to energizing the data center: 51 percent for server and related equipment loads, and 31 percent to the cooling equipment. The power used by the HVAC equipment is a significant amount of the whole building power consumption; it is where energy efficiency opportunities can be taken. A 15 to 50 percent reduction in HVAC electricity use can be achieved. This corresponds to 190 to 633 kW of electricity savings. Lighting power was calculated based on a design watt per square foot value. "Other" contributes 13 percent of the whole building load; it includes items such as losses of power in the electrical equipment, office plug loads, electrical room cooling equipment, and other office space conditioning equipment.

The power energizing the data center floor remains relatively constant throughout the day. This can be verified by examining Chart 4, which shows the power drawn by the server loads in a section of the data center over a period of five days. The server load power varied ± 1.6% from the average of 428 kW. This indicates that power drawn remains the same regardless of the peak time usage of the servers and supporting equipment. The increase in power drawn midday of January 4 is due to the addition of more equipment by customers.

Table 1. End-Use of Electricity

Description	Electricity Consumption (kW)	% of Whole Building	Square Feet (sf)	Watts / sf
Whole Building	4,000	--	118,700	34
Data Center Server Load	2,040	51	60,400	34
Data Center CRAC Units	1,240	31		20
Office Space Conditioning	29	1	58,300	0.5
Lighting	173	4	118,700	1.5
Other	423	13	118,700	4.4

Chart 2. Facility 2 Electricity End-Use

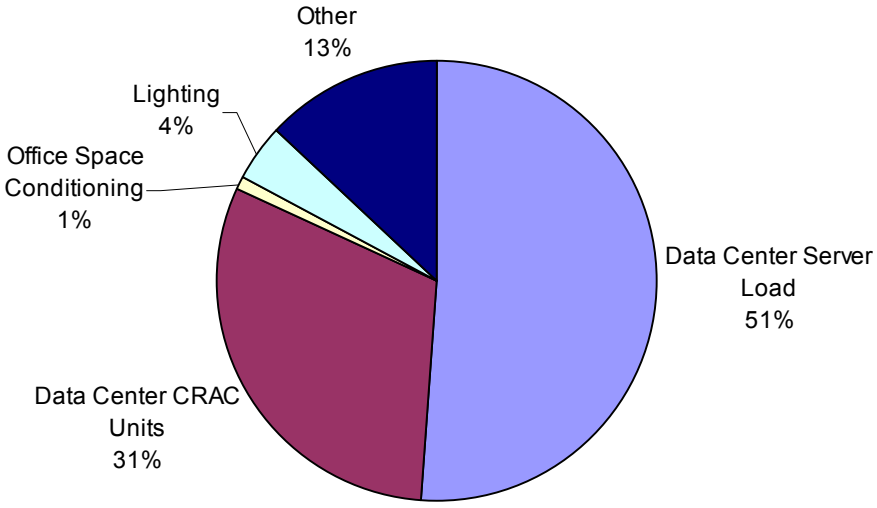


Chart 3. Facility 2 Operating Energy Densities

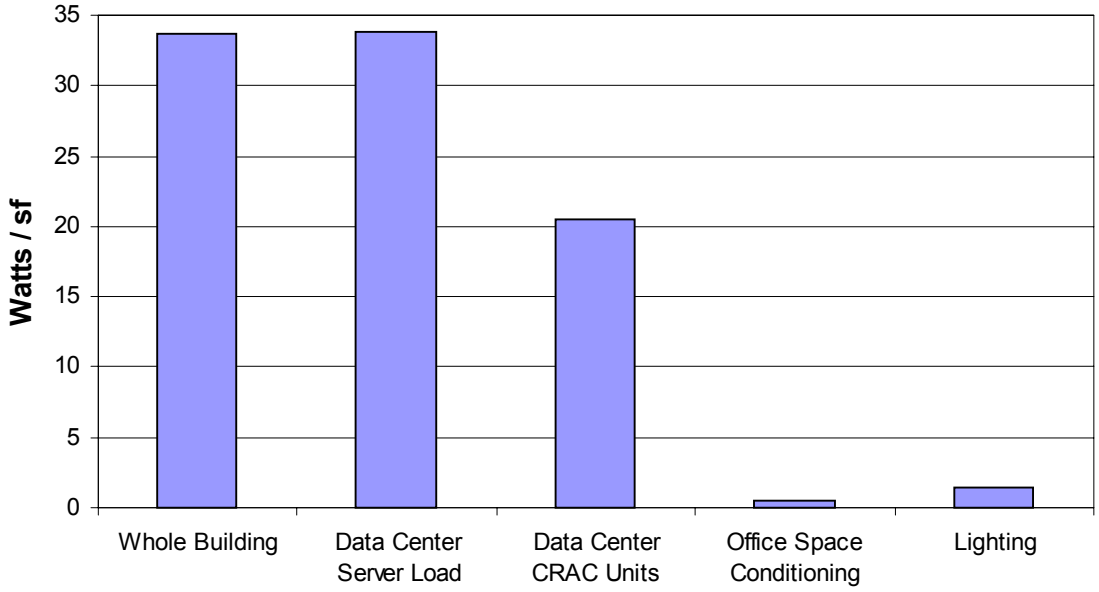
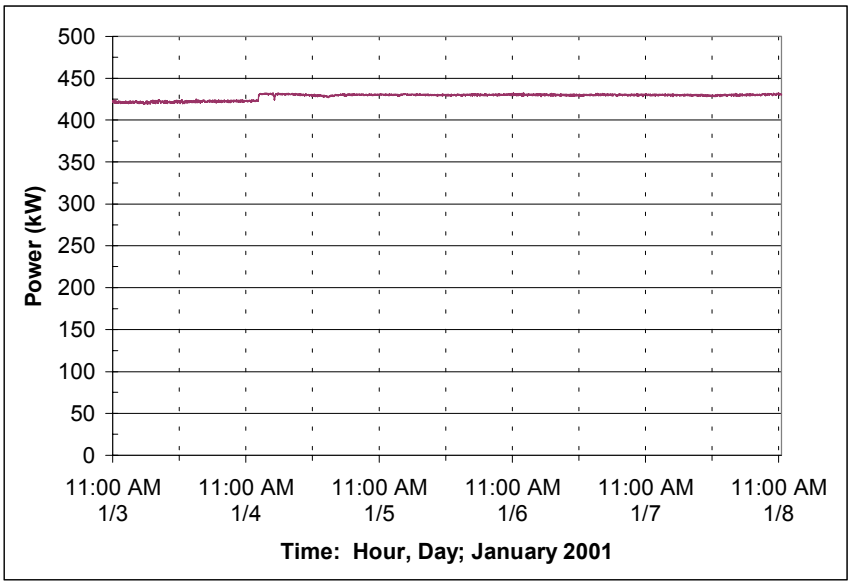


Chart 4. Constant Power Drawn by Server Loads in Data Center



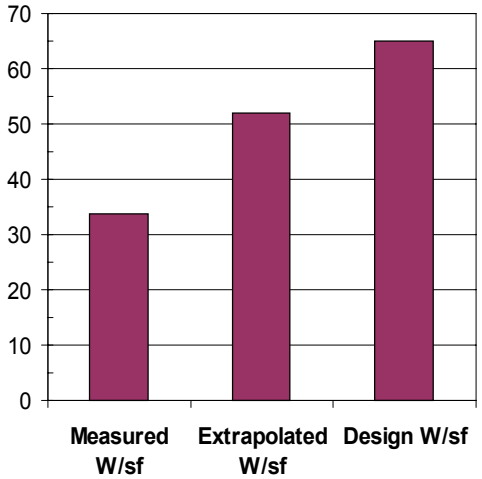
III. Electricity Use Diversity

In determining the size of the equipment needed in a data center facility, designers, in most cases, use an energy density value expressed in watts per square foot (W/sf). The type and number of server equipment in the data center are difficult to estimate, designers therefore oversize electrical equipment, so that a lack of capacity will not be a concern. Table 2 shows the operating conditions of the facility in comparison with the designed conditions. Also, an extrapolated value was calculated to determine what the operating W/sf would be if the data center were fully loaded.

Table 2. Server Load Diversity Factor

Measured W/sf	34
Extrapolated Full Load W/sf	52
Design W/sf	65
Diversity Factor (Measured / Design)	0.52
Diversity Factor (Extrapolated / Design)	0.80

Chart 5. Server Load Density



The data center was only 65 percent occupied at the time of monitoring. Thus 65 percent of the 60,400 sf area was used in calculating the extrapolated data center server load. The extrapolated diversity factor of 0.80 demonstrates that when the data center is fully occupied, it will operate at 80 percent of the expected or designed load.